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ABSTRACT

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In this paper, we use Data Envelopment Analysis (DEA) to estimate how well China's urban areas absorb migrant workers under the interaction of urbanization and industrialization. We applied an output-oriented BCC model to evaluate provincial and regional rural labor absorption efficiency in mainland China. It appears that 4 out of 31 provinces and municipals are efficient, and 2 out of 8 economic regions are efficient in absorbing migrant workers. In the southern and eastern parts of China, urban labor absorption efficiency is higher compared with the western and northern parts of China. Different urbanization patterns and industrial development strategies should be adopted in different economic areas to enhance labor absorption ability in these areas. Urban areas in many parts of China still have potential to accommodate rural migrant workers. The inter-regional flow of production factors would affect urban labor absorption efficiency.

JEL Classification: J61, R23

Keywords: rural labor absorption in urban areas, urbanization, industry structure, DEA

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1 Introduction

Rural labor migration, from agriculture to non-agricultural sectors and from rural to urban areas, is unavoidable in the process of China's economic and social development. Currently, as a result of a large increase in rural migrant workers and the total workforce[1], a challenge exists in rural labor migration and employment: An increasing number of migrant workers coinciding with soaring numbers of university graduates, veterans and unemployed urban workers, all of which exacerbates employment pressure in urban areas. Facing this challenge, a crucial question should be answered: Where should these migrant workers go? The key to this question lies in the labor absorption efficiency of urban areas[2].

Theoretically, the labor absorption efficiency in a particular city depends on its industrial structure and urbanization pattern, which interact with each other to optimize labor force allocation and distribution (Pu & Wu, 2005; Deng & Dan, 2005; Wang & Dai, 2006). Economic development promotes industrial clusters in urban areas, along with high remuneration (Taylor, 2002), improved infrastructure (Au Chun-Chung et al, 2006a, 2006b) and more employment opportunities, which attracts workers from rural areas. Adjustments to industrial structure also lead to reasonable allocation and utilization of migrant workers (Wu et al. 2003). Therefore, interaction between industrial structures and urbanization determines rural labor absorption efficiency in a particular area. A reasonable strategy for rural labor migration should consider these two factors, take advantage of labor absorption and economic strength and influence in urban areas to achieve an optimum allocation of labor resources and promote industrial adjustment and economic development.

China is a developing country with a large territory. However, currently, urbanization in China is not in line with industrial development, resulting in negative influences on the development of non-agriculture industries and restricting job creation (Lu, 2005). Remarkable regional differences in urbanization patterns and industrial structures result in variations to labor absorption abilities among cities. That raises the question: Given different development patterns in different regions, what kind of urbanization strategy and industrial development plan should be adopted in

[1] According to the National Monitoring Report for Migrant Workers (2009), the total number of rural workers is 229million, among which, 148.89 million are migrate workers; 2010, the total number of rural workers reached 242million.

[2] Two sectors are major recipients of rural workers: One is non-agriculture sector in rural areas and the other is non-agriculture sector in urban areas (Lu, 2005). In the past, the labor absorption ability in rural areas is determined largely by the prosperity of township enterprises, while in the late 1990s, labor absorption ability in township enterprises decreased gradually (Yu & Jiang,2003; Kong & Wang 2005), rendering a decreasing labor absorption ability in rural non-agriculture sector. Thus, urban non-agriculture sector, as the major destination for rural workers, serves as the key to deal with challenges proposed by increasing rural workers.

each economic region to improve rural labor absorption? In-depth research should be taken to study the relationship between urbanization, industry structure and rural labor migration so that proper strategies would be adopted to enhance the ability of urban areas to absorb rural labor. Based on Data Envelopment Analysis, this paper uses the output-oriented BCC model to assess the rural labor absorption efficiency in urban areas in 31 provinces and municipals and 8 economic regions that have different patterns and levels of urbanization and different industrial structures.

Following the above introduction of motivation, this paper is set out as follows. Chapter 2 provides literature reviews on rural labor migration, followed with an introduction on methods and data sources in Chapter 3. Empirical results are presented in Chapter 4, and conclusions are drawn in Chapter 5.

2 Literature Review

Current research on rural labor migration focuses on conditions, reasons and determinants for rural labor migration, as well as migration patterns. It is believed that rural labor migration has two connotations. One is workers migrating from rural areas to urban areas, and the other is workers migrating from the agriculture sector to non-agriculture sectors (Lu, 2005). Also, most studies have noticed the relationship between urbanization patterns, industrial structures, as well as rural labor migration. However, the impact of urbanization patterns and industry structure on rural labor migration are examined separately.

In regards to the influence of industrial structure and inter-sector migration of migrant workers, various analyzing methods were adopted[3] to reach the following conclusions: 1) The number of immigrants in a certain area is strongly correlated with the output of major sectors; 2) The classic theory[4] that industrial adjustment would drive workers from the agricultural sector to non-agricultural sectors is confirmed in China; 3) A proper and orderly movement of rural labor could be achieved by a well-designed strategy of inter-regional industrial structure adjustment (Wu Xianman et al, 2003; Wang Xinhua& Dai Weizhou, 2006; Pu Yanping& Wu

[3] These methods include: Cobb Douglas Production Model (Kong Lingcheng,2003; Li Zhongsheng,2003; Wang Dewen, 2004; Chen Feng, 2008); grey correlation analysis (Zhou Jianan, 2006); correlation and regression analyses(Zhang Dongping, 2001; Cao Guoping& Cao Yuequn, 2005); Data Envelopment Analysis (Yang Deli, Chi Xu,1995); Shift-Share-Analysis (Wayne C. Curtis，1972；Hannu Tervo， Paavo Okko，1983；Prentice L. Knight III，1988； Xia Jiechang, 2000; Pu Yanping & Pu Yongjian, 2005; Liang Xiangdong&Yin Yunjie, 2005; Lu Qi, Zhang Chaoyang, 2008)

[4] Classic studies on this topic include: Colin，G•Clark（1939）Chapter IX: The Distribution of Labour between Industries; Chapter X: Relative Incomes and Other Factors Controlling the Supply of Labour to Different Industries and Occupations, The conditions of economic progress[M], Macmillan and Co., Limited (1940); Simon Smith Kuznets, Economic growth of nations: total output and production structure, Belknap Press of Harvard University Press, 1971; Chenery and M. Syrquin (1975), Patterns of Development, 1950-1970, Oxford: Oxford University Press for the World Bank,1975.

Yongqiu, 2005; Deng Zhituan& Dan Taobo, 2005; Cheng Mingwang & Shi Qinghua, 2007); 4) In China, regional variations of labor absorption ability in non-agriculture sectors still exist (Deng Zhituan & Dan Taobo, 2005; Cao Ming et al , 2007).

When it comes to the relationship between urbanization and rural migrant workers, research concentrates on the theoretical analysis of urbanization and its implications for rural labor migration. It is shown that urbanization would impact the migration of migrant workers by increasing the income gap between urban and rural areas (ZhaoYaohui，1999；Au Chun-Chung et al.，2005) or by increasing non-currency profit, such as more education opportunities, improved living conditions and frequent social interactions (Au Chun-Chung et al.，2005；Douglas S. Massey，1999；2004a；2004b；2005；Munshi Kaivan ，2003；Calvo Armengol A.& Jackson M. O.，2004；Wallace E. Huffman & Scott. Rozelle，2004). A city's population density, demographics and size have positive influences on the number of workers migrating from rural areas to urban areas. The number of citizens in immigration provinces would have positive effects on the migration volume of inter-provincial labor (Kevin Honglin Zhang，Shunfeng Song 2003；Au Chun-Chung et al. 2005). The influence of different urbanization patterns on rural labor migration are also studied by comparing the labor absorption ability in large cities and small towns (Gu Shengzu, 1996; Wang Yue, 2008). Whether China should choose to develop more metropolises, large cities or small towns in order to deal with problems proposed by increasing rural migrant workers is still open to debate (Wang Xiaolu, 1999; Zhou Tianyong, 2011).

In addition, some researchers have noticed an underlying interaction between urbanization and industrialization. They indicate that the agglomeration effect brought about by industrial structure adjustment serve as a major driving force of urbanization (Lucas，1988；Black & Henderson，1999；Murata，2002；Davis & Henderson，2003；Ma Chunhui，2004). At the beginning, development of the industrial clusters of a city's central area leads to the expansion of urban areas. This gradually results in the development of relative industrial clusters in nearby cities or towns and finally contributes to the development of larger cities or even metropolitan circles (Davis & Henderson，2003；Li Qinjuan，2003；Ma Chunhui，2004；Su Xuechuan，2004；Ji Lianggang、Chen Xiaoyong，2005). At the same time, different urbanization patterns have different requirements on its industrial distributions (Li Chenggu, 2004; Liu Yanjun, 2006). As is stated by some scholars, large cities tend to attract high-tech, innovation-oriented and intelligence-intensive industries, while small and medium-sized cities are more likely to be a warm bed for clusters of labor-intensive industries (Zeng Fenyu, 2002; Huangpo, Chen Liuqin, 2006; Zheng Heng& Zhang Guoping, 2007) .

To sum up, researchers from home and abroad have paid attention to the relationship between rural labor migration and urbanization patterns, as well as the

relationship between rural labor migration and industry structure adjustments. However, effective strategies for rural labor migration in China combining urbanization patterns with industrial distributions have not yet received enough attention. Therefore, it is meaningful to conduct further research to study the aforementioned questions and provide a particular angle for strategic consideration on rural labor migration in China.

3 Methods and data

3.1 Methods

DEA is an efficiency evaluation model based on mathematical programming theory, which can be used to assist in identifying best-practice performance in the use of resources amongst a group of organizations (Decision Management Units, or DMUs). DEA is developed around the basic idea that the efficiency of a DMU is determined by its ability to transform inputs into desired outputs. In this approach, the ratio of output to input is usually less than or equal to1 (Output/Input$\leq$1), which is based on assumption that some energy loss will always occur during the transformation process. DEA generalizes this single output/input technical efficiency measure to multiple outputs/inputs by constructing a relative efficiency measure based on a single virtual output and a single virtual input. The efficiency frontier is then determined by selecting DMUs that are most efficient in producing a virtual output from a virtual input. DMUs on the efficiency frontier have an efficiency score equal to 1; inefficient DMUs are measured relative to the efficient DMUs. It is too haste to say that DMUs judged to be efficient are categorically optimizing the use of inputs to produce outputs. They are relatively more efficient than other DMUs that do not get full efficient scores. However, such identification can highlight where the greatest gains can be made from improvements in efficiency and help each DMU to achieve their full potential.

In contrast to parametric approaches such as regression analysis, which calculate data through a single regression plane, DEA optimizes each individual observation with the objective of calculating a discrete piece-wise frontier determined by the set of Pareto-efficient DMUs. Furthermore, DEA calculations are non-parametric and do not require an explicit prior determination of relationships between inputs and outputs or a rigid set of weight based on importance for the various factors. DEA can also readily incorporate multiple outputs and be used to calculate technical and scale efficiency using only information from output and input quantities.

DEA is used in this paper to explore technical and scale efficiency of rural labor

absorption in urban areas in China. Technical efficiency means that a DMU cannot produce more output from its existing inputs. In the case of rural labor absorption, this means that a technically efficient urban area is not able to absorb more migrant workers given its existing urbanization pattern and industry structure. Scale efficiency means that a proportional increase or decrease in a DMU's inputs would result in the same proportional increase or decrease in its output. In the case of rural labor absorption, this means that the proportional change of output in scale-efficient urban area equals its proportional change of input.

More formally, let us assume that there are n DMUs to be evaluated. Each DMU consumes varying amounts of m different inputs to produce s different outputs. Specifically, DMU_j consumes amounts $\{Xj = x_{ij}\}$ of inputs (i=1, 2,…, m) and produces amounts $\{Yj = y_{rj}\}$ of outputs (r=1, 2, …, m). The $s \times n$ matrix of output measures is denoted by Y, and the $m \times n$ matrix of input measures is denoted by X. Also, let us assume that $x_{ij} > 0$ and $y_{rj} > 0$. Consider the problem of evaluating the relative efficiency for any one of the n DMUs, which will be identified as DMU_0. Relative efficiency for DMU_0 is calculated by forming the ratio of a weighted sum of outputs to a weighted sum of inputs, subject to the constraint that no DMU can have a relative efficiency score greater than unity. Symbolically:

$$\max \frac{\sum_r u_r y_{r0}}{\sum_i v_i x_{i0}} = \frac{u^T Y_0}{v^T X_0}, \text{ where } u=(u_1,u_2,\ldots,u_s)^T,\ v=(v1,v2,\ldots,v_m)^T$$

Subject to:

$$\frac{u^T Y_j}{v^T X_j} = \frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}} \leq 1$$

For j=1, 2, …, n; $u_r, v_i \geq 0$ for $r = 1, 2, \ldots, s$ and $i = 1, 2, \ldots, n$, where u_r and v_i are weights assigned to output r and input i, respectively. By introducing a scalar quantity, θ (defining $\theta = \frac{1}{v^T X_0}$, $\mu T = \theta \mu^T, w = \theta v^T$.), to adjust the input and output weights, this fractional programming problem with a potentially infinite number of optimal solutions could be solved (Charnes et al., 1978).

Appropriate substitutions produce the CCR LP problem:

$$\max \sigma_0 = \sum_r \mu_r y_{r0} = \mu^T Y_0$$

Subject to

$$w^T X_0 = \sum_i w_i x_{i0} = 1, \qquad \sum_r u_r y_{rj} - \sum_i w_i x_{ij} \leq 0, \qquad w_i, u_r \geq \in$$

Where the value of σ_0 is the relative efficiency of DMU_0 and $\in$ is a positive constant, called the non-Archimedean infinitesimal, which is introduced to facilitate solving of the linear programming problem. In DEA, this LP is known as the CCR model, as it was developed by Charnes, Cooper and Rhodes.

When using the CCR model, it is assumed that all the DMUs have constant returns to scale. However, in many cases, inefficiency in DMUs not only results from improper distribution of inputs, but from improper production scale. This alters the initial assumption of constant returns to scale, leading to assumptions of variable returns to scale.

In 1984, Banker, Charnes and Cooper introduced the BCC model, which is based on variable returns to scale. This model divides the score of technology efficiency (TE) into pure technology efficiency (PTE) and scale efficiency (SE). Since labor absorption ability in urban areas cannot be restricted to constant returns to scale, for this paper, the BCC model based on variable returns to scale is adopted with output orientation. Output orientation focuses on the amount by which outputs can be proportionally increased without increasing the resource base.

Symbolically:

Max μ

Subject to $X_{i0} \geq \sum_{j=1}^{n} X_{ij}\lambda_j \ , i = 1,2,\dots,m$ (1)

$$Y_{r0}\,\mu \leq \sum_{j=1}^{n} Y_{rj}\lambda_j, \ r = 1,2,\dots,s \qquad (2)$$

$$\sum_{j=1}^{n} \lambda_j = 1 \qquad (3)$$

$$\lambda_j \geq 0, \quad j = 1,2,\dots,31 \qquad (4)$$

Where X_{ij} refers to input i (1，2，…，m) to DMU j (j=1，2，…，n), Y_{rj} refers to output r (r=1，2，…，s) to DMU j. λ_j refers to non-negative weight of DMU j. μ refers to the score of technology efficiency. When μ=1, the input sets are on the production frontier, leading to best output level. Then the DMU's relative efficient.

When $\mu<1$, the input sets of the DMU cannot produce optimal output efficiently. And, the lower the score is, the less efficiency DMU has.

3.2 Measures and data of input and output

In this paper, two sets of evaluation will be made. For provincial analysis, the set of DMUs consists of data from 31 provinces and municipals in mainland China. For regional analysis, the set of DMUs consists of data from 8 economic regions divided according to their urbanization patterns and industry structures.

Rural labor absorption ability is viewed as the output of the model. Urbanization patterns and industrial structures are viewed as inputs of the model. Measures of input and output, as well as their data sources, are illustrated as follows:

Output measure：Rural Labor Absorption Ability in Urban Areas, which is indicated by **Numbers of Migrant workers in Urban Units (2009)**[5]**：** This indicates workers with a rural *hukou* (household registration) while working in urban enterprises and institutions. Data source: China Labor Statistical Yearbook 2010.

Input measure: Urbanization Patterns[6]**, urbanization level**[7] **and Industrial structures**

(a)**Proportions of large cities**[8] **in a Province**: This indicator calculates the

[5] Since no credible provincial or regional data source for the amount of rural labor migration could be found, for this paper, Numbers of Rural Workers in Urban Units was chosen to measure the Rural Labor Absorption Ability in urban areas.

[6] So far, no uniform and exact definition of urbanization pattern has been put forward. Literatures on this topic refer urbanization pattern as strategies adopted during the process of urbanization. The following factors are most often considered in literatures on urbanization patterns: 1) The relationship between urbanization and industrialization; 2) The speed of urbanization; 3) Proportion of large cities, medium-sized cities and small towns in urban hierarchy; 4) The interaction between cities within an urban circle; 5) Policy issues concerning urbanization control and management; 6) Dynamic mechanisms of urbanization. Currently, studies on urbanization and labor migration tend to investigate the relationships and interactions between different-sized cities on their ability to absorb rural workers. Based on previous studies, this paper chose to use the proportion of large cities, medium-sized cities and small towns in urban hierarchy to describe urbanization patterns in different areas.

[7]. Urbanization level is usually measured by two indicators: One of them is urban population, which describes the percentage of the total population living in urban areas, and the other is the rate of urbanization, which describes the projected average rate of change of the size of the urban population over the given period of time. In this paper, we use the former one as an indicator of urbanization level.

[8] According to the City Planning Law of the Peoples Republic of China, enacted in 1989, a “large city” means one which has a non-agricultural population of 500,000 or more in its urban and inner suburban districts. A “medium-sized city” means one which has a non-agricultural population of more than 200,000 but less than 500,000 in its urban and inner suburban districts. A “small city” means one which has a non-agricultural population of less than 200,000 in its urban and inner suburban districts. However, this law was abolished on January 1, 2008. In the first Green Book on the development of China’s small and medium-sized cities, clear definitions for a megacity, metropolis, large city, medium-sized city and small city are illustrated. According to that report, a "megacity " means one which has more than 10 million permanent residents; a "megacity metropolis" has between 3 million and 10 million permanent residents; a "large city" has between 1 million and 3 million permanent residents; a "medium-sized city" has between 0.5 million and 1 million permanent residents, and a "small city" has less than 0.5million permanent residents. The same definitions are adopted for this paper.

proportion of cities with more than 1 million permanent residents in a province[9]. This indicator is designed to identify urbanization patterns in terms of the proportion of large cities of a province. Three different types of urbanization patterns would be categorized. When this indicator is larger than 70%, it shows that the province or economic region has adopted an urbanization strategy that gives priority to large cities. When the indicator falls between 40%-70%, the province or economic region has adopted an urbanization strategy that balances the development of large cities with that of small and medium-sized cities. If the indicator falls below 40%, then the province or economic region has adopted an urbanization policy giving priority to small and medium-sized cities.

（**b**）**Urban Primacy Index** (four-city-index, 2009)：The Urban Primacy Index is an indicator that explains variation in the steepness or flatness of city size hierarchies by evaluating the population distribution within an area. A primate city can be defined as the central place in an urban or city network that has acquired or obtained a great level of dominance. The primate city concept was first presented by Mark Jefferson[10] (1939), based on the assumption that a concentration of political and economical power in an area also allows for the concentration of wealth and, therefore, of population. Thus, by calculating the population concentration within an area, the primate city and its dominant power are easily identified. Jefferson defines a primate city as being "at least twice as large as the next largest city and more than twice as significant. He compared the population ratio of the largest city with that of the second-largest city ($S=P_1/P_2$) to describe population concentration in an area as well as the dominant power of the primate city. Several other indicators of population concentration have been used by researchers. Davis (1969) used a population ratio of the largest city to the sum of the next three cities: $S=P_1/(P_2+P_3+P_4)$. In this paper, we use the urban primacy index (four-city-index) to evaluate the dominant power and economic influence of core cities. Also, the indicator serves as a reference to define the pattern of urbanization in a certain area. We use data extracted from China City Statistical Yearbook 2010 for calculation.

(c) Urbanization Level: ——The **Percentage of the Urban Population Relative to Total Population** (2009): The term urbanization can represent the level of urban development relative to overall population, or it can represent the rate at which the urban proportion of an area is increasing. In this paper, the term urbanization represents the level of urban citizens relative to overall population within a province or an economic region. Data source: China Statistical Yearbook 2010.

[9] Here, the numbers of megacities and metropolis are included.
[10] Mark Jefferson. "The Law of the Primate City", in Geographical Review 29 (April 1939)

(d) Industrial Structure：Two indicators are usually used to describe industrial structure. One is the proportion of output value in agriculture and secondary and tertiary industries, and the other is employment levels in the three industries. In this paper, however, we use the ratio of the two indicators to describe characteristics of the industrial structure of different regions, namely the deviation of industrial structure and employment. When the indicator is less than 1, it means that an industry is experiencing employment pressure. When this indicator is more than 1, it means the industry has the potential to absorb more workers. We use data from China Statistical Yearbook 2010 to calculate this indicator.

Specifically, indicators used in this paper are presented in Table1 and Table 2

(Insert Table 1and Table 2)

4 Results

4.1 Provincial analysis on rural labor absorption efficiency

Based on Data Envelopment Analysis, rural labor absorption efficiency in 31 provinces and municipals of mainland China is evaluated. The efficiency scores are presented in Table 3 and relate to the year 2009.

(Insert Table 3)

Several findings are presented as follows:

4.1.1 Four Provinces obtain full efficiency score while show distinctive ability in absorbing rural labor force.

Four provinces are on the production frontier, with a full efficiency score. They are Zhejiang province, Guangdong province, Xinjiang autonomous region and Tibetan autonomous region. In addition, the four provinces showed distinctive ability to accommodate migrant workers. Zhejiang province and Guangdong province accommodated large quantities of migrant workers (1.05 million and 1.28 million respectively), while Xinjiang Autonomous Region and Tibetan Autonomous Region, showed relatively poorer ability to accommodate migrant workers among 31 provinces and municipals (0.104 million and 0.011 million respectively). This could be explained by analyzing their urbanization patterns as well as industrial strategy.

Zhejiang and Guangdong province both achieved balanced development in the process of urbanization. Zhejiang, located in eastern China, benefits greatly from the advancement of urban agglomerations in the area. With major cities such as Hangzhou, Jiaxing, Shaoxing, Ningbo, Huzhou, and Zhoushan, a coordinated

urbanization pattern that combines large cities with small and medium-sized cities is achieved. Although there are no megacities or metropolis in the province, its small and medium-sized cities are highly developed with advanced economies, enhancing the effect of urban agglomeration in the area. Guangdong, located in southern China, has an urbanization pattern that emphasizes on the development of large cities. Its provincial capital, Guangzhou, with a population of 6.46 million in 2009, is a city of strong economic influence. With the help of Hong Kong and Macau, Guangzhou has been a strong economic driving force for the development of Guangdong. When it comes to the industrial structures of the two provinces, Zhejiang and Guangdong have advanced secondary and tertiary industries. Specifically, in Zhejiang, the production value of its second industry is higher than that of its tertiary industry, concentrating on labor-intensive manufacturing industries such as textile, leather processing, clothing, furniture manufacturing, chemical industry, medicine, rubber manufacturing, plastic products, building materials, metal, machinery industry, transportation equipment, electrical machinery, electronic instruments, meters, etc. Based on its advantages in attracting foreign investment, the labor-intense manufacturing industry used to be the dominant industry in Guangdong. Currently, the high-tech sector and the tertiary industry are prospering and have become key industries for Guangdong. In 2009, the province's secondary and tertiary industries were worth 1.93 trillion yuan and 1.78 trillion yuan respectively, with a production value proportion of 49.20% and 38.70% respectively. Although production value in the secondary industry is a little higher than that of the tertiary industry, the proportion of employment in the tertiary industry (38.70% in 2009) is higher than the secondary industry (34.10% in 2009).

Despite achieving full efficiency scores, the number of migrant workers absorbed by Xinjiang autonomous region and Tibetan autonomous region remains at a relatively low level. That is because high labor absorption efficiency does not necessarily lead to large quantities of absorbed migrant workers. The two autonomous regions have low urbanization rates. The urbanization rate in Xinjiang is 40% and the urbanization rate in Tibet is 24% in 2009. The capital city of the Tibetan autonomous region, Lhasa, has a population of around 0.186 million in 2009, with very weak economic influence. Without large cities and metropolis, fractures exist in Tibet's urban hierarchy, leading to the lack of a driving force to link city development in the region. Xinjiang autonomous region, however, lacks well-developed medium-sized cities to allow development in large cities to influence small cities. Thus, labor demand for migrant workers is low. In terms of industrial structure, employment in the primary industry accounts for a large proportion of total employment in both regions: 54.5% in Tibetan autonomous region and 51.3% in Xinjiang autonomous region in 2009. At the same time, secondary and tertiary industries in the two regions fail to create adequate demand to absorb migrant workers.

Analyzing the four provinces with full efficiency scores, it is showed that not all provinces with full efficiency end up accommodating large amount of migrant workers. The efficiency score has no correlation with the quantity of migrant workers being absorbed. However, by evaluating efficiency, subtle implications underlying the labor absorption ability can be discovered and traced.

4.1.2 Yunnan province, Guangxi province, Hunan province, Shanxi province, Heilongjiang province, and Hainan province are technically inefficient in absorbing migrant workers.

Technical efficiency, in this paper, evaluates the effect of interactions of urbanization and industrialization on labor absorption efficiency in urban areas. As shown in the analysis, the technical efficiency scores of Yunnan province, Guangxi province, Hunan province, Shaanxi province, Heilongjiang province, and Hainan province are all less than 1, which means these provinces are technically inefficient in absorbing rural labor. These provinces, except Hainan, are all located in western China. The labor absorption ability in the provinces is restricted as a result of lower numbers of large cities and metropolis, relatively poor economic influence, significant employment in primary industries[11], and limited development of secondary industries.

4.1.3 Most provinces are inefficient with a scale efficiency score of less than 1.

Those provinces, except Heilongjiang, Zhejiang, Guangdong, Xinjiang autonomous region and Tibet autonomous region, are inefficient with a scale efficiency score of less than 1. As shown in empirical results, the provinces all show increasing returns to scale, which means that increasing inputs would result in a proportional increase in output. To improve urbanization and industrial adjustment, those provinces can tap their potential and accommodate more migrant workers.

4.2 Regional analysis on rural labor absorption efficiency

China is a country with vast terrain but unbalanced regional economic development. Considering that similarities and differences between regions may have great influence on regional urbanization and industrial distribution and thus greatly affect labor absorption efficiency, it is necessary to evaluate rural labor absorption efficiency on the basis of regional data.

In this paper, 31 provinces and municipals in mainland China are divided into 8 economic regions according to their urbanization patterns and industrial structures. Major information on these economic regions is presented as follows:

[11] In 2009, primary industries in Yunnan province, Guangxi province, Hunan province, Shaanxi province and Heilongjiang province, Hainan province accounted for 61.3%, 54.5%, 48%, 45.7%, 46.3%, 52.4%, respectively, of total employment.

(Insert Table 4)

Based on DEA of 2009 data, rural labor absorption efficiency in 8 economic regions of mainland China is evaluated and efficiency scores are listed in Table 5. Several findings are presented as follows:

(Insert Table 5)

4.2.1 The Pearl River Delta Economic Region and the Yangzi River Delta Economic Region are relatively efficient in absorbing migrant workers.

Based on empirical analysis, the Pearl River Delta Economic Region and the Yangzi River Delta Economic Region have relatively optimum efficiency in absorbing migrant workers. As the two most developed economic regions in China, they are also major destinations for migrant workers. In 2009, the number of migrant workers working in the Pearl River Delta Economic Region and Yangzi River Delta Economic Region was 1.897 million and 1.795 million respectively.

Located on the east coast of China, the Yangzi River Delta is one of the most developed economic regions with the highest level of urbanization. The most advanced and promising cities in China, such as Shanghai, Nanjing, Suzhou, Hangzhou, Wuxi, Ningbo and Nantong, are located in this area, leading to strong economic development in adjacent cities. For example, eight cities in Jiangsu province topped the list in economic growth rate, with the highest growth rate at 19.1%, the lowest growth rate at 14% and the average growth rate 1.1 percentage points higher than the national average[12]. Simultaneously, small and medium-sized cities in the area exert strong development potential, allowing for balanced development throughout the entire urban hierarchy. Small and medium-sized cities in the region excel in labor-intensive manufacturing and wholesale industries, creating many employment opportunities. As a result, intra-regional labor migration and inter-regional labor migration are both active, contributing to high migrant worker absorption numbers and efficiency in the area.

Over the past 30 years, the Pearl River Delta Economic Region has played a pioneering role in China's reform and opening-up process. As a result, it has undergone a dramatic change, shifting from a frontier agricultural region to one of the nation's strongest economic regions. Urbanization level in the region is relatively high, with advanced urban circles in Guangzhou, Shenzhen, Shantou, Fuzhou, Xiamen, etc. As a result of its unique geographical position, the Pearl River Delta Economic Region, together with Hong Kong and Macau, utilized foreign investment to forge

[12] China Statistic Yearbook, 2010

itself into a globally competitive area. With most of the investment flowing into the area immediately surrounding the delta, the region has injected vitality to the prosperity of southern China. Economic prosperity in urban areas have led to further development of industrial clusters focusing on labor-intensive manufacturing and high-tech industries, creating substantial employment opportunities. Coordinated interactions between urbanization and industrial advancement in this region have contributed to high efficiency in rural labor absorption.

4.2.2 The Xinjiang-Tibet Economic Region present a relatively high labor-absorption efficiency score while small quantities of absorbed migrant workers.

Empirical results show that despite having the second-highest efficiency score of 0.930 for absorbing migrant workers, the number of migrant workers working in Xinjiang-Tibet Economic Region remains at the bottom among eight economic regions. Economic development and urbanization in the area is in its infancy because of tough natural conditions and transportation limitations. Cities in the region cannot provide an agglomeration effect and less-developed non-agriculture industries cannot produce surplus employment opportunities. Despite a high efficiency score, underdeveloped urbanization combined with a lower level of industrialization contribute to a limited ability to absorb large numbers of migrant workers.

4.2.3 Efficiency of rural labor absorption in Northeast Economic Region and Shaanxi-Gansu-Ningxia-Qinghai Economic Region

Relatively low scores in efficiency of rural labor absorption in the Northeast Economic Region and the Shaanxi-Gansu-Ningxia-Qinghai Economic Region are found in regional analysis (0.177 and 0.148 respectively).

In terms of urbanization patterns, both regions have lower proportions of large cities. In 2009, the large city proportion was 36% in the Northeast Economic Region and 69% in the Shaanxi-Gansu-Ningxia-Qinghai Economic Region. Lacking core cities with strong economic power and sound industrial development and with relatively poor economic performance in small and medium-sized cities, the two regions fail to attract resources that can contribute to coordinated development of urban agglomeration. Moreover, primary industries account for a large proportion of employment in both regions. In 2009, primary industries in Shaanxi-Gansu-Ningxia-Qinghai Economic Region accounted for 46% of total employment, while production value accounted for only 9% of total output. In the Northeast Economic Region, primary industries accounted for 39% of total employment and only 11% of total output. That means secondary industries in these

regions cannot assume the burden of absorbing migrant workers.

5 Conclusions and implications

Based on empirical analysis, major conclusions are drawn as follows:

5.1 A ladder-shaped difference exists in rural labor absorption efficiency in China’s urban areas, with scores in southeast China higher than that of northwest China.

DEA indicates that the rural labor absorption efficiency increases from Northwest China to Southeast China. Provincial efficiency analysis shows two provinces with full efficiency scores, namely Guangdong and Zhejiang province, are located along China’s east coast. Three out of the four provinces (Qinghai, Heilongjiang, Gansu) with the lowest efficiency scores are located in the western region of China. Regional efficiency analysis indicates that two economic regions with full efficiency scores are the Pearl River Delta Economic Region and the Yangtze River Delta Economic Region, which are along China’s east coast as well.

The rationale behind this phenomenon can be the interaction of industrial distribution and urbanization patterns in the regions. The growth and vitality of industrial clusters along the east and south coasts of China depend mainly on foreign investment (such as the Pearl River Delta Economic Region) and economic interaction between geographically adjacent cities and towns. At the same time, the urbanization rate in the eastern or southern parts of China is much higher than that of northern or western China, along with a more rational urban hierarchy and coordinated development of small, medium-sized and large cities. In western China, most industrial clusters are highly dependent on natural resources, with relatively poor interaction among major cities and towns. A mismatch in urbanization patterns and industrial distribution contributes to low migrant labor absorption efficiency in western China.

5.2 Provinces and regions with joint development of small, medium-sized and large cities and towns, and concentration on labor-intensive and high-tech industries enjoy high migrant labor absorption efficiency

Provinces and economic regions that enjoy full migrant labor absorption efficiency and large quantities of absorbed migrant labor, as is shown in the Data Envelopment Analysis, have something in common. They adopt an urbanization strategy of joint development of small, medium-sized and large cities and towns and concentrate on labor-intensive, high-tech and tertiary industries. The urbanization strategy takes advantage of the market influence of large cities to promote urban agglomeration and improve economic development in adjacent small and

medium-sized cities. In that way, core competitiveness in urban areas is cultivated, attracting more migrant workers. At the same time, labor-intense manufacturing industry and rapid development of high-tech industry, serve to produce tremendous employment demand, resulting in stronger labor accommodation ability. Urbanization pattern, coordinating with proper industry structure, serves to make rural labor absorption efficiency achieves nature of best. In this respect, their experience is worth to draw lessons from.

5.3 Different adjustments should be adopted in different provinces and economic structures to enhance rural labor absorption efficiency.

As is shown in empirical analysis, most economic regions, in terms of rural labor absorption ability, are at the stage of increasing return to scale. That means there is enormous potential for these areas to accommodate migrant workers if proper policies would be adopted to promote urban agglomeration and industry structure adjustment.

Specifically, according to their economic and social conditions, different strategies should be made to enhance rural labor absorption efficiency in these economic regions.

(1) Emphasis should be placed on the development of metropolis and large cities in Pan-Northeast Economic Region, raising economic radiation ability of central cities, making full advantage of rapid industrial development, ensuring coordinated development of industrialization and urbanization.

(2) Bohai Sea Economic Region, enjoys highest large-city proportion among eight economic regions. However, lacking medium-sized cities, which result in a fracture in city hierarchy, has a negative effect on rural labor absorption efficiency in these areas. Thus, it is necessary to develop small and medium sized cities to achieve coordinated development in urban hierarchy.

(3) Comparing with Bohai Sea Economic Region and Northeast Economic Region, the Central Economic Region have higher rural population density and less per capita arable land, resulting in more surplus rural labor force. However, secondary industry in this area depends more on nature resources than on labor force. The tertiary industry in this area is less developed and fails to accommodate large amounts of migrant workers. At the same time, fractures exist in urban hierarchy, with few medium sized cities and relatively weak urban economic power. The radiation and transmission effects on industry, products, technology, capital and other aspects between large cities and small cities are almost broken. Thus, to improve labor absorption efficiency in Central Economic Region, emphasis should be put on the development of medium sized cities. Also, by adjusting its current industrial structure and accepting labor-intense industries from eastern and southern China, inner-regional

migration would increase, leading to the enhancement in rural labor absorption efficiency.

(4) The Shaanxi-Gansu-Ningxia-Qinghai Economic Region and the Southwest Economic Region share some common features in development background. Lying on Chinese border, the two regions are blessed with abundant resources. Though with strong primary industry, the developments of secondary and tertiary industry are relatively weak with limited labor absorption ability. Therefore, urbanization policy in future should focus on the development of core cities, improving their economic power and radiation effects. The two regions should take the opportunity to accept transferred labor-intense industries from eastern and southern China, and at the same time, improve its current industries to form strong agglomeration effect. In this way, labor absorption efficiency could be enhanced.

(5) Future development in Xinjiang-Tibetan Autonomous Region should be focused on developing a relatively coordinated city network combining large cities, medium sized cities and small cities. Also industries with local characteristics should be upgraded, creating more employment opportunities.

5.4 Limits and restrictions on provincial and regional rural economic interaction should be relaxed to achieve the optimum efficiency in labor absorption ability.

The average score of provincial rural labor absorption efficiency is 0.271, while regional average score of rural labor absorption efficiency, higher than that of provincial analysis, is 0.577. At the same time, Pearl River Delta Economic Region, containing Hainan Province that has a relative low efficiency score, enjoys a full efficiency score. This indicates that inter-regional flow of capital, resources, labor force as well as techniques, act to promote interactions between urbanization process and industrial development, contributing to higher rural labor absorption efficiency. Thus, a series of policies should be adopted to optimize inter-regional resource allocation and relax limit on inter-regional labor migration, providing guidance to ensure a proper and orderly movement of migrant workers.

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Tables

Table1 Measures of Input and Output for Provincial Analysis

	Indicators
Inputs	Urban Primacy Index（UPR）, Proportion of Permanent Residents in Urban Areas(P_U), Deviation of Industrial Structure in Primary Industry (I_a), Deviation of Industrial Structure in Secondary Industry (I_b), Deviation of Industrial Structure in Tertiary Industry, Proportion of Large Cities (U)
Output	Number of Migrant workers in Urban Units (N)

Table2 Measures of Input and Output for Regional Analysis [13]

	Indicators
Inputs	Urban Primacy Index（UPR）, Proportion of Permanent Residents in Urban Areas(P_U), Deviation of Industrial Structure in Primary Industry (I_a), Deviation of Industrial Structure in Secondary Industry (I_b), Deviation of Industrial Structure in Tertiary Industry, Proportion of Large Cities (U)
Output	Number of Migrant workers in Urban Units (N)

Table 3 Provincial Analysis on Rural Labor Absorption Efficiency

	VRSTE	**Technical Efficiency (TE)**	**Scale Efficiency (SE)**	**Returns to Scale**
Zhejiang	**1**	**1**	**1**	**-**
Guangdong	**1**	**1**	**1**	**-**
Tibetan Autonomous Region	**1**	**1**	**1**	**-**
Xinjiang Autonomous Region	**1**	**1**	**1**	**-**
Fujian	0.718	1	0.718	Increasing returns to scale
Beijing	0.466	1	0.466	Increasing returns to scale
Jiangsu	0.447	1	0.447	Increasing returns to scale
Shandong	0.284	1	0.284	Increasing returns to scale
Average Efficiency	**0.271**	**0.829**	**0.368**	**-**
Shanghai	0.256	1	0.256	Increasing returns to scale
Sichuan	0.226	1	0.226	Increasing returns to scale

[13] Measurements of input and output in regional analysis are calculated based on provincial data.

Yunnan	0.209	0.672	0.311	Increasing returns to scale
Hebei	0.145	1	0.145	Increasing returns to scale
Chongqing	0.14	1	0.14	Increasing returns to scale
Inner Mongolia Autonomous Region	0.138	1	0.138	Increasing returns to scale
Henan	0.135	1	0.135	Increasing returns to scale
Liaoning	0.131	1	0.131	Increasing returns to scale
Guangxi	0.119	0.46	0.258	Increasing returns to scale
Ningxia	0.117	1	0.117	Increasing returns to scale
Hubei	0.114	1	0.114	Increasing returns to scale
Tianjin	0.111	1	0.111	Increasing returns to scale
Guizhou	0.097	1	0.097	Increasing returns to scale
Anhui	0.095	1	0.095	Increasing returns to scale
Hunan	0.086	0.194	0.442	Increasing returns to scale
Shaanxi	0.069	0.193	0.355	Increasing returns to scale
Shanxi	0.069	1	0.069	Increasing returns to scale
Jiangxi	0.062	1	0.062	Increasing returns to scale
Jilin	0.052	0.122	0.429	Increasing returns to scale
Gansu	0.048	1	0.048	Increasing returns to scale
Heilongjiang	0.03	0.03	1	Increasing returns to scale
Qinghai	0.015	1	0.015	Increasing returns to scale
Hainan	0.012	0.015	0.806	Increasing returns to scale

Table 4 Information on Eight Economic Regions

Name	**Provinces**	**Urbanization patterns**	**Industry structure**	**Migration patterns of migrant workers**
Yangtze River Delta Economic Region	Shanghai, Zhejiang, Jiangsu	A combination of large cities, small and medium-sized cities with advanced towns	Labor-intensive manufacturing industry and wholesale trading.	Intra-regional migration combined with inter-regional migration
Pearl River Delta Economic Region	Guangdong, Fujian, Hainan	A combination of large cities, small and medium-sized cities, with a great number of	High-tech manufacturing industry, labor-intensive industry, and	Intra-regional migration combined with inter-regional migration

Name	Provinces	Urbanization patterns	Industry structure	Migration patterns of migrant workers
		advanced medium-sized cities	advanced tertiary industry.	
Northeast Economic Region	Heilongjiang, Jilin, Liaoning	Multi-polar urban circles, lacking regional core city.	Major agriculture base in China with heavy industries on energy, mining and metallurgy	Inter-regional migration
Bohai Sea Economic Region	Beijing, Tianjin Hebei, Shandong	Multi-polar urban circles with advanced megacities and metropolises	Heavy industries based on natural resources with high-tech industries in Beijing	Intra-regional migration
Central Economic Region	Hunan, Anhui, Hubei, Jiangxi, Henan	Urbanization pattern with emphasis on medium-sized cities	Less developed tertiary industry with dominant agriculture industry	Inter-regional migration
Southeast Economic Region	Yunnan, Sichuan, Chongqing, Guizhou, Guangxi	Urbanization pattern with emphasis on small and medium-sized cities, lacking regional core city	Heavy industries based on nature resources, with employment focusing on primary industry.	Inter-regional migration
Shaanxi-Gansu-Ningxia-Qinghai Economic Region	Shaanxi, Shanxi, Gansu, Ningxia, Qinghai and Inner Mongolia Autonomous Region	Urbanization pattern with emphasis on medium and small sized cities, lacking regional core city	High production value and low employment in secondary industry.	Inter-regional migration
Xinjiang-Tibet Economic Reigion	Xinjiang autonomous region, and Tibet autonomous region	Lacking advanced cities in urban hierarchy	High employment in primary industry and low employment in secondary industry.	Inter-regional migration

Table 5 Regional Analysis on Rural Labor Absorption Efficiency

Name of economic region	VRSTE	Technical Efficiency(TE)	Scale Efficiency (SE)	Returns to Scale
Pearl River Delta Economic Region	1.000	1.000	1.000	-
Yangtze River Delta Economic Region	1.000	1.000	1.000	-
Bohai Sea Economic Region	0.564	1.000	0.564	Increasing returns to scale
Southeast Economic Region	0.497	1.000	0.497	Increasing returns to scale
Central Economic Region	0.303	1.000	0.303	Increasing returns to scale
Shanxi-Gansu-Ningxia-Qinghai Economic Region	0.148	1.000	0.148	Increasing returns to scale
Northeast Economic Region	0.177	1.000	0.177	Increasing returns to scale
Xinjiang-Tibet Economic Region	0.930	1.000	0.930	Increasing returns to scale